ZOOLOGY
http://www.revistas.unal.edu.co/index.php/cal

https://dx.doi.org/10.1544 6/caldasia.v40n2.71887
Caldasia 40(2):255-261. Julio-diciembre 2018

Morphological description of an alate female of *Zorotypus hamiltoni* New (Zoraptera: Zorotypidae) from Colombia

Descripción morfológica de una hembra alada de *Zorotypus hamiltoni* New (Zoraptera: Zorotypidae) de Colombia

GERMÁN VILLAMIZAR[1*], LUIS ANTONIO GONZÁLEZ-MONTANA[2]
*[1]*Universidad Nacional de Colombia (Sede Bogotá). Facultad de Ciencias. Instituto de Ciencias Naturales, Grupo Insectos de Colombia. Cra. 30 # 45 – 03, edificio 425. Bogotá, Colombia. germanvc91@gmail.com*
[2]Universidad Nacional de Colombia (Sede Bogotá). Facultad de Ciencias Agrarias. Museo Entomológico Facultad de ciencias Agrarias UNAB, Grupo Sistemática de Insectos, Agronomía SIA. Cra. 30 # 45 – 03, edificio 500. Bogotá, Colombia. lagonzalezmo@unal.edu.co
** Corresponding author.*

ABSTRACT
An alate female of *Zorotypus hamiltoni* from Colombia is described and illustrated for the first time. The single specimen was collected in Santa María, Boyacá, Colombia and is currently deposited at the Museo Entomológico. Universidad Nacional, Agronomía, Bogotá, Colombia (UNAB).

Key words. Angel insects, Boyacá, ground lice, neotropical region, Santa María.

RESUMEN
Una hembra alada de *Zorotypus hamiltoni* de Colombia es descrita e ilustrada por primera vez. El espécimen fue colectado en Santa María, Boyacá, Colombia y actualmente está depositado en el Museo Entomológico. Universidad Nacional, Agronomía, Bogotá, Colombia (UNAB).

Palabras clave. Boyacá, insectos ángel, piojos de tierra, región neotropical, Santa María.

INTRODUCTION

Zoraptera, also known as ground lice or angel insects, is one of the less known insect lineages in the world in terms of distribution, diversity and biology (Mashimo *et al*. 2014). The zorapterans are tiny insects (approximately 2-4 mm length) superficially resembling barklice (Psocoptera) or termites (Blattodea). Specimens in this order are gregarious, often living in loose colonies composed by up to 150 individuals (Engel 2009). Since the morphological description and taxonomic work carried out by Silvestri (1913), research related to Zoraptera is increasing, indicating that it is an order that has much to be discovered. Significant advances in this century are related to morphology (Beutel and Weide 2005, Friedrich and Beutel 2008, Dallai *et al*. 2012, 2013), paleontology (Grimaldi and Engel 2005, Engel 2008, Yin *et al*. 2018), taxonomy and systematics (Engel 2000, 2007, Rafael and Engel 2006, Rafael *et al*. 2008) and biological events such as gynandromorphism and parthenogenesis (Rafael *et al*. 2017).

Currently, 44 extant and 13 fossil species are known worldwide, distributed mainly in tropical and subtropical regions (Terry and Whiting 2012, Mashimo *et al*. 2013, 2018, Wang *et al*. 2016, Kočárek *et al*. 2017, Yin and Li 2017, Liu *et al*. 2018, Yin *et al*. 2018) including 17 occurring in the Neotropical

CC BY

region (Rafael *et al*. 2008). However, males, females, nymphs or alate morphs are unknown for most species (Rafael and Engel 2006). The knowledge about the diversity of zorapterans in Colombia is minimal, only the species *Zorotypus hamiltoni* New, 1978, has been recorded based solely in a male specimen and the paratypes (alate female forms) were dealate prior capture and the wings remained unknown (Rafael and Engel 2006).

One of the main reasons why the diversity of zorapterans is poorly known in Colombia is the lack of native researchers engaged in studying these magnificent insects. Likewise, is not yet clear what collecting methods are best to be used and which environments or substrates are suitable for find them in the country (MS Engel, pers. com.). Therefore, any kind of contribution to the Zoraptera study has great value considering the current state of knowledge and how rare they are in the collections. The aim of this work is to make available for the first time a complete and detailed morphological description of an alate female of *Z. hamiltoni*, as a contribution to the study of Neotropical zorapterans.

MATERIALS AND METHODS

The specimen studied was preserved in 80 % alcohol following the curatorial standards of Martínez-Alava and Serna (2015). Morphological terminology follows Engel (2000), Rafael and Engel (2006) and Engel (2008). Labial and maxillary palpomeres were numbered from the base to the apex. Abdominal terga and sterna are indicated as T8, T9, S8, S9, etc., respectively. The nomenclatural terminology for wing venation follows Kukalová-Peck and Peck (1993). The term "alate" is used for individuals that are fully winged with developed compound eyes and ocelli. Measurements are given in millimeters. Body length was measured from the head, excluding antennae, to the apex of abdomen in lateral view. Fore and hind wings were measured from the anterior margin of tegula to the tip of the wing. Photomicrographs were obtained using a Leica M205A stereomicroscopic equipped with a camera and the software LAS 4© (Leica Application Suite) provided by Departamento de Biología of the Universidad Nacional de Colombia. The photographs were enhanced with Adobe Lightroom® (ver. 7.0). Illustrations of general morphology were vectorized with the free software Inkscape and Adobe Photoshop® (ver. 13.0). The specimen studied was identified using the original description of *Zorotypus hamiltoni* and the identification was posteriorly confirmed by Michael S. Engel of the University of Kansas, United States. The information label of the specimen studied was transcribed under the section "Material examined".

RESULTS

Material examined. A single alate female with the following data label: Colombia, Boyacá, Santa María, 4°51'52" N 73°15'40" W, 960 m, Captura en trampa Malaise, 23 dic 2016, Col. J.M. Perilla, UNAB4585. The specimen is currently housed at the Museo Entomológico. Universidad Nacional, Agronomía, Bogotá, Colombia (UNAB).

Morphology. Female (Figs. 1-3). *Measurements* (mm). Body length: 2.17 (excluding antennae); antennal length: 1.39; head length: 0.42; pronotum length: 0.43; pronotum width: 0.55; forewing length: 2.95; forewing width: 0.8; hind wing length: 2.27; hindwing width: 0.60: metafemoral width: 0.19; metafemoral length: 0.66; metatibial length: 0.74.

Integument predominantly dark brown except yellowish white (almost translucent) on the last two antennomeres, yellowish on maxillary and labial palps, light brown on legs and pale white in membranous regions (Fig. 1a).

Figure 1. Alate female of *Zorotypus hamiltoni*, left lateral view of habitus. Last antennomere of left antenna is lacking. Scale bar = 1 mm.

Head (Figs. 2c, 3a). Subtriangular, slightly wider than pronotum; vertex without central, paramedian row of pronounced cluster of divergent, slender setae; compound eyes black; vertex with three ocelli; antennae with nine antennomeres: first cup-shaped, second narrow with length approximately one third of third antennomere, remaining antennomeres longer than wide, length of each similar to that of first antennomere. Head with paired setae forming longitudinal rows of four convergent setae bordering midline; distal half of labrum with long paired setae. Mandible with short rounded subapical tooth. Galea with toothed-like comb at the apex. Maxillary palpus 5-segmented, fifth palpomere two times longer than third, fourth palpomere shorter than third; second and third palpomeres with sub equal length. Labial palpus 3-segmented, third palpomere compressed dorsolaterally with similar length to the lengths of first and second palpomeres together.

Thorax (Fig. 3b). Pronotum in dorsal view subrectangular (slightly wider than long), anterior region slightly wider than posterior, predominantly flat without ridges along margins; setae long and dense mainly on anterior and posterior margins, hairs on disc shorter and scattered (Fig. 2c). Mesonotum slightly smaller than pronotum with anterior margin narrower than posterior (trapezoidal shape). Metanotum trapezoidal, wider than long with long setae on posterior margin.

Wings (Figs. 2a-b). Brown-hyaline with dense pubescence. Forewing veins M and Rs weak and nebulous; pterostigma present on anterior margin between R and Rs veins; R vein coarse, reaching the base of pterostigma and evanescent below it; Rs far away of the wing tip and it reaches the C vein close to the pterostigma; veins rs-m present, slightly longer than the abscissa of Rs; M thin, extended to posterior margin; M+Cu coarse and nebulous; CuA_1 extending from posterior

margin of the wing; CuA_2 very short, almost absent. Hind wing with R+M, R and M_{1+2} veins well defined being M vein weaker; R and M_{1+2} fused near the antero-basal margin of wing; M short, starting near the base of the wing; Cu absent.

Legs (Figs. 1a, 2d-e). Compressed dorsolaterally with regular setae of moderate length on the dorsal surface, ventral surface almost glabrous; pro and mesofemur with regular setae, denser apically; pro and mesotibia with setae on ventral surface and two apical spines; metafemur approximately three times longer than broad, more swollen basally, posterior ventral surface with nine paired long stiff spines evenly spaced, the first five longer than the others; metatibia with two dorsal stiff spurs at the apex, slightly longer than the ventral setae.

Abdomen (Figs. 2f, 3c-e). Posterior margin of each tergum with a transverse row of long setae evenly spaced, the number of setae varies on each, noticeably more numerous on T8-T10; T10 uniformly sclerotized with a pair of setae of moderate length on posterior margin; disc with numerous short setae; T11 sclerotized, with few setae and without projections. Sterna with evenly spaced long

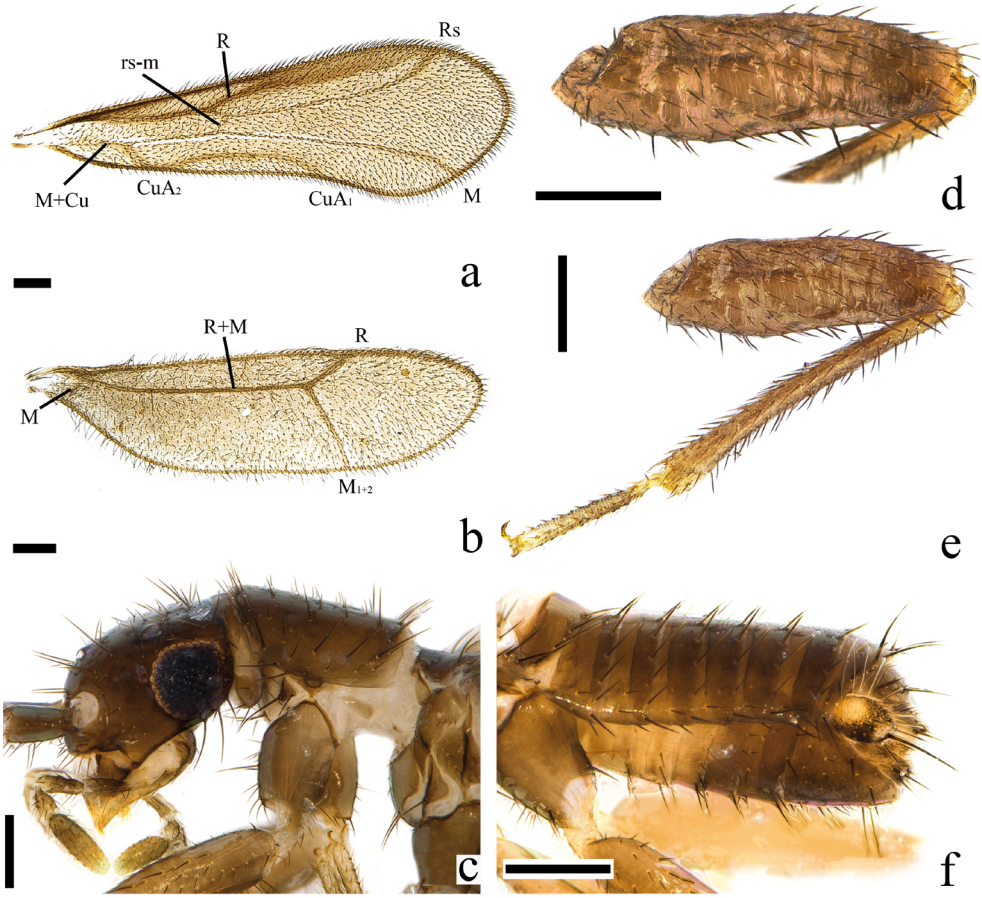

Figure 2. Alate female of *Zorotypus hamiltoni*. **a**. Forewing; **b**. Hindwing; **c**. Left lateral view of head and pronotum; **d**. Anterior view of right metafemur; **e**. Anterior view of right metaleg; **f**. Left lateral view of abdomen. Scale bars = 0.2 mm.

setae (similar to tergal setae) along posterior margin, S8 and 9 with short setae on disc; posterior margin of S8 broadly rounded, not fused with S9; process on basal margin of S9 broadly spaced, with several short setae on disc and two longer hairs. Cerci conical with slightly acute apex and numerous long preapical setae; apical setae stouter than other cercal setae; preapical setae thin and long; short and dense spicules in the middle area of cerci.

Remarks

Santa María is located within the department of Boyacá between 600 m and 1200 m high. This region is characterized by periods of humid and rainy climates mainly in the months of April and October (IGAC 1977), generating suitable habitats for the establishment of zorapterans based on the observations previously made by Mashimo *et al*. (2014), Yin *et al*. (2015) and Matsumura and Njoroge (2016) where these specimens live in humid environments. Those areas are predominated by mosses, lichens in wood bark which are frequently found in the sampled locality.

Frequently these insects are captured directly or by aspirators considering their gregarious biology, however, curiously the alate female of *Z. hamiltoni* was captured in a Malaise trap. This capture methodology could be useful for winged zorapterans if the trap is placed in an appropriate environment. In addition, this trap reaches a greater sampling effort compared to direct capture.

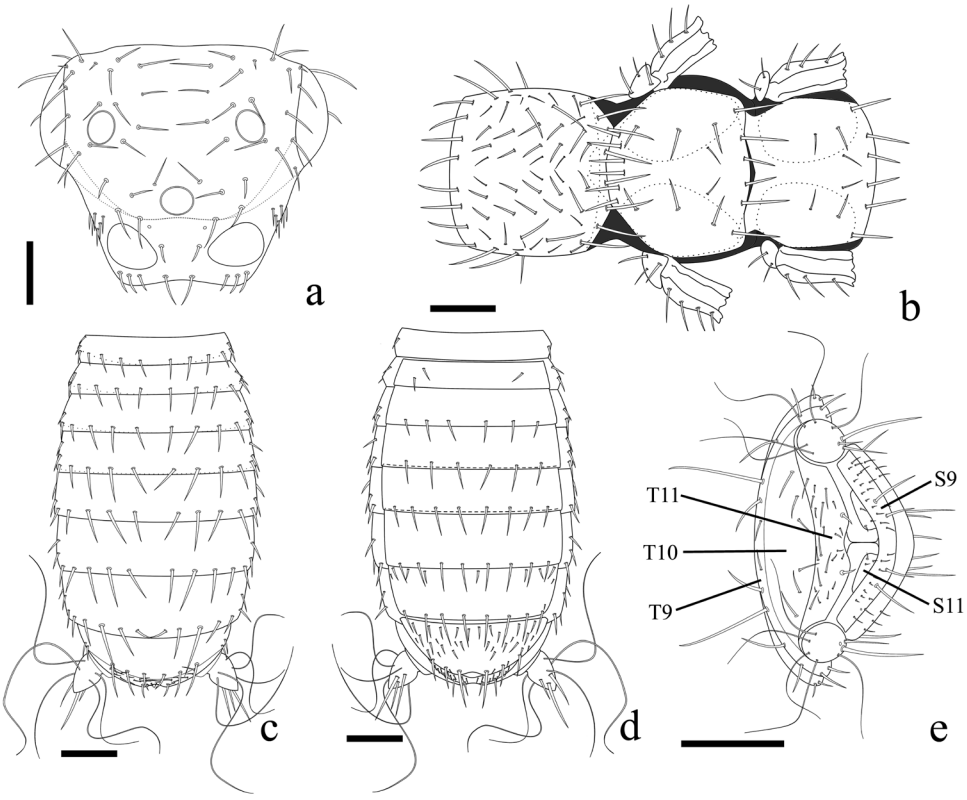

Figure 3. Alate female of *Zorotypus hamiltoni* (appendages removed). **a**. Head (frontal view, antennae removed); **b**. Thorax (dorsal view, wings removed); **c**. Abdomen (dorsal view); **d**. Abdomen (ventral view); **e**. Abdominal terminalia (posterior view). Scale bars = 0.2 mm.

AUTHOR'S CONTRIBUTION

LAGM examination of specimen, morphological description, paper writing; GV examination of specimen, photographs and illustrations, morphological description, paper writing.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

ACKNOWLEDGMENTS

We want to thank Michael Engel for his constant support and collaboration in the realization of this work. We also extend our thanks to Francisco Serna for the loan of specimen and the preliminary revision of this work, Felipe Vivallo, María Oliva Diaz and Leonardo Malagón Aldana for their help in the development of this article.

LITERATURE CITED

Beutel RG, Weide D. 2005. Cephalic anatomy of *Zorotypus hubbardi* (Hexapoda: Zoraptera): New evidence for a relationship with Acercaria. Zoomorphology 124(3):121–136. doi: 10.1007/s00435-005-0117-z.

Dallai R, Gottardo M, Mercati D, Machida R, Mashimo Y, Matsumura Y, Beutel RG. 2013. Divergent mating patterns and a unique mode of external sperm transfer in Zoraptera: An enigmatic group of pterygote insects. Naturwissenschaften. 100(6):581–594. doi: 10.1007/s00114-013-1055-0.

Dallai R, Mercati D, Gottardo M, Dossey AT, Machida R, Mashimo Y, Beutel RG. 2012. The male and female reproductive systems of *Zorotypus hubbardi* Caudell, 1918 (Zoraptera). Arthropod Struct. Dev. 41(4): 337–359. doi: 10.1016/j.asd.2012.01.003.

Engel MS. 2000. A new *Zorotypus* from Peru, with notes on related Neotropical species (Zoraptera: Zorotypidae). J. Kansas Entomol. Soc. 73(1):11–20.

Engel MS. 2007. The Zorotypidae of Fiji (Zoraptera). Bishop Mus. Occ. Papers 91:33–38.

Engel MS. 2008. A new apterous *Zorotypus* in Miocene amber from the Dominican Republic (Zoraptera: Zorotypidae). Acta Entomol. Slov. 16:127–136.

Engel MS. 2009. Zoraptera. In: Resh VH, Cardé RT, editors. Encyclopedia of Insects, 2nd Edition. New York: Academic Press. p. 1069–1070.

Friedrich F, Beutel RG. 2008. The thorax of *Zorotypus* (Hexapoda, Zoraptera) and a new nomenclature for the musculature of Neoptera. Arthropod Struct. Dev. 37(1):29–54. doi: 10.1016/j.asd.2007.04.003.

Grimaldi DA, Engel MS. 2005. Evolution of the Insects. Cambridge: Cambridge University Press.

[IGAC] Instituto Geográfico Agustín Codazzi. 1977. Estudio general de suelos del Valle de Tenza, región de Lengupá y municipio de Pesca, departamento de Boyacá. Bogotá: Instituto Geográfico Agustín Codazzi.

Kočárek P, Wahab RA, Abdul Kahar SR. 2017. *Zorotypus asymmetricus* sp. nov. from Brunei Darussalam, Borneo (Insecta: Zoraptera). Zootaxa 4286(2):285–290. doi: 10.11646/zootaxa.4286.2.11.

Kukalová-Peck J, Peck SB. 1993. Zoraptera wing structures: Evidence for new genera and relationship with the blattoid orders (Insecta: Blattoneoptera). Syst. Entomol. 18(4):333–350. doi: 10.1111/j.1365-3113.1993.tb00670.x.

Liu J, Zhang W, Cai W, Li H. 2018. Two new species of angel insects in mid-Cretaceous Burmese amber (Zoraptera: Zorotypidae). Cretaceous Res. 90:259–264. doi: 10.1016/j.cretres.2018.05.001.

Martínez-Alava JO, Serna F. 2015. Managing insect collections. Micropezidae (Diptera: Nerioidea) of the Entomological Museum UNAB. Agron. Colomb. 33(3):339–347.

Mashimo Y, Matsumura Y, Beutel RG, Njoroge L, Machida R. 2018. A remarkable new species of Zoraptera, *Zorotypus asymmetristernum* sp. n., from Kenya (Insecta, Zoraptera, Zorotypidae). Zootaxa 4388(3):407–416. doi: 10.11646/zootaxa.4388.3.6.

Mashimo Y, Matsumura Y, Machida R, Dallai R, Gottardo M, Yoshizawa K, Friedrich F, Wipfler B, Beutel RG. 2014. 100 years Zoraptera - a phantom in insect evolution and the history of its investigation. Insect Syst. Evol. 45(4):371–393. doi: 10.1163/1876312X-45012110.

Mashimo Y, Yoshizawa K, Engel MS, Ghani I.A, Dallai R, Beutel RG, Machida R. 2013. *Zorotypus* in Peninsular Malaysia (Zoraptera: Zorotypidae), with the description of three new species. Zootaxa 3717(4):498–514. doi: 10.11646/zootaxa.3717.4.4.

Matsumura Y, Njoroge L. 2016. A new record of Zoraptera (Insecta) from Kenya, with remarks on their habitat. J. East Afr. Nat. Hist. 105(2):213–222. doi: 10.2982/028.105.0202

New TR. 1978. Notes on Neotropical Zoraptera, with descriptions of two new species. Syst. Entomol. 3(4):361–370. doi: 10.1111/j.1365-3113.1978.tb00005.x.

Rafael JA, Marques DWA, Engel MS. 2017. The first gynandromorph of a zorapteran and potential thelytokous parthenogenesis in a population of *Zorotypus brasiliensis* Silvestri (Zoraptera: Zorotypidae). Rev. Bras. Entomol. 61(4):318–322. doi: 10.1016/j.rbe.2017.09.001.

Rafael JA, Engel MS. 2006. A new species of *Zorotypus* from central Amazonia, Brazil (Zoraptera: Zorotypidae). Am. Mus. Novit. 3528:1–11. doi: 10.1206/0003-0082(2006)3528[1:ansozf]2.0.co;2.

Rafael JA, Godoi FSP, Engel MS. 2008. A new species of *Zorotypus* from eastern Amazonia, Brazil (Zoraptera: Zorotypidae). Trans. Kans. Acad. Sci. 111(3/4):193–202. doi: 10.1660/0022-8443-111.3.193.

Silvestri F. 1913. Descrizione di un nuovo ordine di insetti. Boll. Lab. Zool. gen. agr. Fac. Agr. Portici 7:193–209.

Terry MD, Whiting MF. 2012. *Zorotypus novobritannicus* n. sp., the first species of the order Zoraptera (Zorotypidae) from the Australasian Ecozone. Zootaxa 3260:53–61.

Wang J, Li H, Cai W. 2016. *Zorotypus weiweii* (Zoraptera: Zorotypidae), a new species of angel insects, from Sabah, East Malaysia. Zootaxa. 4162(3):550–558. doi: 10.11646/zootaxa.4162.3.8.

Yin ZW, Cai C, Huang D. 2018. New zorapterans (Zoraptera) from Burmese amber suggest higher paleodiversity of the order in tropical forests. Cretaceous Res. 84:168–172. doi: 10.1016/j.cretres.2017.11.028.

Yin ZW, Li LZ. 2017. *Zorotypus huangi* sp. nov. (Zoraptera: Zorotypidae) from Yunnan, southern China. Zootaxa. 4300(2):287–294. doi: 10.11646/zootaxa.4300.2.10.

Yin ZW., Li LZ., Wu C. 2015. New and little known species of *Zorotypus* Silvestri (Zoraptera: Zorotypidae) from China. Zootaxa 4007(5):557–566. doi: 10.11646/zootaxa.4007.4.6.

Received: 09/05/2018
Accepted: 16/07/2018